

BAKER BOTTS L.L.P.
30 ROCKEFELLER PLAZA
NEW YORK, NEW YORK 10112

TO ALL WHOM IT MAY CONCERN:

Sub A2
Be it known that WE, ~~MATTI KIIK, residing at 2500 Springwood Lane,~~
Richardson, County of Dallas, State of Texas, ~~75082~~; ~~ROBERT JOSEPH TOBIN, residing~~
at 121 Oakview Drive, ~~Double Oak, County of Denton, Texas 75077~~; ~~LOUIS T. HAHN,~~
residing at ~~110 Oak Tree Drive, Waxahachie, County of Ellis, Texas~~; and ~~MARGIE A.~~
~~BEERER, residing at 702 South Hall Street, Ennis, County of Ellis, Texas~~; citizens of the
United States of America, have invented an improvement in

HEAT REFLECTIVE COATED STRUCTURAL ARTICLE

of which the following is a

SPECIFICATION

In A2
FIELD OF THE INVENTION

This invention relates to a heat reflective coated structural article useful in, for
example, commercial roofing applications comprising a heat reflective component and a coated
structural article component which comprises a substrate having an ionic charge coated with a
5 coating having essentially the same ionic charge. The heat reflective coated structural article of
the present invention is useful for reducing cooling costs when used as a final layer of a roofing
system, particularly a commercial roofing system.

BACKGROUND OF THE INVENTION

Conventional roofing for commercial and industrial buildings usually consists of a roof deck covered by a layer of insulation followed by a water proof membrane and an exterior surface. Many commercial buildings have flat roofs upon which a commercial roofer commonly applies roll roofing in large single sheets. Asphalt is generally applied to the surface of the roof and the roll roofing is then applied on top of the asphalt. Alternatively, the roll roofing may have a layer of asphalt on one surface which is heated to apply the roll roofing to the roof.

There are many problems involving undesirable heat transfer associated with conventional commercial roofing because the roof absorbs solar energy from the sun. As a result, the roof becomes very hot during the day, causing higher interior temperatures and resulting in higher cooling costs. Typical roofing materials such as mineral cap sheets, modified bitumen, asphalt, and gravel can absorb more than 70 percent of the solar energy that falls on them. Roofs having dark roofing materials, which tend to absorb more of the sun's solar energy, may become as hot as 88° C (190° F) on a sunny day. Even lighter colored roofing materials (e.g. white or green) can become as hot as 79° C (175° F).

Certain insulation materials and constructions have been disclosed in the past to reduce cooling costs, including using a liquid medium located on a building structure which can be cooled, such as a water jacketed enclosure. See U.S. Patent Nos. 3,450,192 and 3,563,305 of Hay. U.S. Patent Nos. 3,994,278 and 4,082,080 of Pittinger disclose heating and cooling systems which utilize an energy source and a fluid body as a storage medium. The fluid body is distributed over the roof of a building and includes mechanisms for regulating the temperature

within the enclosed structure. In these types of systems, optimum cooling efficiency cannot be obtained and an external source is needed to obtain the cooling, which results in additional costs.

Other methods for reducing cooling costs comprise applying a reflective coating onto the roof after the roof has been installed (retrofitted coatings) which reduce the amount of solar energy that is absorbed by the roof. Reflective coatings can reflect much of the sun's heat rays and can lead to reduced interior building temperatures and reduced cooling costs. For example, white roof coatings can reflect 70% to 80% of the sun's energy. Reflective coatings may include, *inter alia*, elastomeric coatings, aluminum fiber coatings, acrylic and polyurethane coating systems such as Mule-Hide acrylic and polyurethane coating systems available from Better Roofing Mid Atlantic, Inc. (Jacksonville, North Carolina), ceramic coatings, insulating paints such as those disclosed in U.S. Patent 4,623,390 of Delmonico, metal pigment paints, and metal pigment pastes such as those disclosed in U.S. Patent No. 5,993,523 of Keemer et al. By making the roof less absorptive of the sun's heat rays, significant cooling-energy savings can be achieved. In addition, lighter colored roofs tend to last longer. See <<http://www.energy-seal.com>> visited May 12, 2000.

The Environmental Protection Agency (EPA) and the Department of Energy (DOE) have organized the Energy Star® Roof Products Program which is aimed at reducing cooling costs by using cool roofing products. See <<http://www.energy-seal.com>> visited May 12, 2000. The EPA and the DOE have recognized the energy-saving cost benefits of using reflective coatings on roofs and are advocating their use. The Energy Star® label can be used on reflective roof products that meet the EPA's specifications for solar reflectance and reliability to help consumers identify energy-efficient products. For example, the Energy Star® label may be

used on roof products for low-slope roofs (surfaces with a slope of 2:12 inches or less) that have an initial solar reflectance greater than or equal to 0.65 and that have a solar reflectance greater than or equal to 0.5 three years after installation under normal conditions. As another example, the Energy Star® label may be used on roof products for steep-slope roofs (surfaces with a slope greater than 2:12 inches) that have an initial solar reflectance greater than or equal to 0.25 and that have a solar reflectance greater than or equal to 0.15 three years after installation under normal conditions.

The solar reflectance of roofing products can vary dramatically. For example, the solar reflectance of commercial asphalt shingles is rather low. Premium white shingles have a solar reflectance of around 30%, and other colors reflect less. *See*

<<http://eetd.lbl.gov/coolroof/asshingl.htm>> visited October 27, 2000. The solar reflectance of smooth bitumen roofing membrane is around 6%.

<<http://EandE.LBL.gov/coolroof/membrane.htm>> visited October 27, 2000. The solar reflectance of new, bare galvanized steel is 61%. *See*

<<http://EandE.LBL.gov/CoolRoof/metal.htm#metal>> visited October 27, 2000.

While the cost benefits of reflective coated cool roofing are documented, the cost of installing cool roofing is also an issue. Conventional commercial roll roofing is often coarse and can absorb coating that is applied to it. Such coarse roofing products require the use of significant amounts of reflective coating, which can be costly. Furthermore, conventional commercial roofing generally uses other components such as heavy glass mats, granules and finishes which add to the material and installation costs. Furthermore, conventional commercial

roofs require that the coating be applied after the roof is installed, which also increases installation costs.

Thus, there is a need for an easier, more cost efficient means to apply an energy-efficient reflective surface to commercial roofs. In particular, there is a need for pre-manufactured commercial roofing material which comprises a reflective coating on its surface and is less costly to manufacture and install than conventional commercial roofing materials.

SUMMARY OF THE INVENTION

The present invention provides a heat reflective coated structural article comprising a heat reflective component and a coated structural article component which comprises a substrate having an ionic charge coated with a coating having essentially the same ionic charge. The coating of the coated structural article component consists essentially of a filler material and a binder material wherein the binder material bonds the filler material together and to the substrate and wherein the coating does not bleed through the substrate. The heat reflective component may be selected from the following nonlimiting examples: elastomeric coatings, aluminum fiber coatings, acrylic and polyurethane coating systems such as Mule-Hide acrylic and polyurethane coating systems available from Better Roofing Mid Atlantic Inc. (Jacksonville, North Carolina), ceramic coatings, insulating paints, metal pigment pastes, metal pigment paints, coloring dyes, colored coatings, and aluminum flakes.

The heat reflective coated structural article of the present invention can be incorporated into conventional commercial roofing materials to achieve energy-efficient cool roofing materials. Furthermore, the heat reflective coated structural article of the present

invention eliminates the need for other products, such as glass mats, granules and other finishes typically used in commercial roofing materials, thus reducing the costs of manufacturing and installing the roofing materials. The commercial roofing materials which incorporate the heat reflective coated structural articles of the present invention are easier to handle than conventional commercial roofing materials and may be lighter in weight than other commercial roofing materials. In addition, they eliminate the need for post-installation application of the heat reflective component and they reduce the amount of heat reflective component necessary, both of which reduce the cost of the roofing material.

DETAILED DESCRIPTION

The applicants have discovered that a cost-efficient heat reflective coated structural article for use in commercial roofing materials can be made by combining a heat reflective component with a coated structural article component. The coated structural article component comprises a substrate having an ionic charge coated with a coating having essentially the same ionic charge. The coating of the coated structural article component consists essentially of a filler material and a binder material. For example, United States Patent No. 5,965,257, which is incorporated herein by reference, teaches that by coating the substrate with a coating having essentially the same ionic charge, a zero bleed through product is made while using only two major ingredients in the coating. By producing a coating having essentially the same ionic charge as the substrate, a zero bleed through product may be produced having a low binder content and no viscosity modifiers.

The coated substrate of the coated structural article component may be any suitable reinforcement material capable of withstanding high temperatures such as glass fibers, polyester fibers, cellulosic fibers, asbestos, steel fibers, alumina fibers, ceramic fibers, nylon fibers, graphite fibers, wool fibers, boron fibers, carbon fibers, jute fibers, polyolefin fibers, polystyrene fibers, acrylic fibers, phenol-formaldehyde resin fibers, aromatic and aliphatic polyamide fibers, polyacrylamide fibers, or mixtures thereof which may include bicomponent or multicomponent fibers.

The filler employed in the coating of the coated structural article component may be class F fly ash, class C fly ash or mixtures thereof. Preferably, the filler is class F fly ash wherein 90% to 95% by weight of the fly ash is aluminosilicate. Such a fly ash, known as Alsil O4TR, is produced by ISG Industries, of Kennesaw, Georgia. Alternatively, the filler may be charged calcium carbonate or ceramic microspheres, or a blend of fly ash and calcium carbonate, or a blend of fly ash, calcium carbonate, ceramic microspheres and dolomite.

The table below provides, in percentages, some of the combinations of calcium carbonate, fly ash and ceramic microspheres which may be utilized as the filler component in the coating:

TABLE I

| | A | B | C | D | E | F |
|------------------|----------|----------|----------|----------|----------|----------|
| | % | % | % | % | % | % |
| 20 1. Water | 18.9 | 25.9 | 37.33 | 25.9 | 24.9 | 24.9 |
| 2. Acrylic Latex | 6.0 | 6.0 | 6.42 | 6.0 | 6.0 | 6.0 |
| 3. Fly Ash | 75.0 | 34.0 | ----- | 40.0 | ----- | 20.0 |

| | | | | | | |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 4. CaCO ₃ | ----- | 34.0 | ----- | ----- | 40.0 | 20.0 |
| 5. Microspheres | ----- | ----- | 56.14 | 28.0 | 29.0 | 29.0 |
| 6. Defoamer | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| | <u>100%</u> | <u>100%</u> | <u>100%</u> | <u>100%</u> | <u>100%</u> | <u>100%</u> |

5

The microspheres may be a 50/50 ratio of 3M's W1012 microspheres and 3M's smaller diameter G200 microspheres. Although the table shows possible combinations of calcium carbonate, fly ash and ceramic microspheres in the filler component of the coating, it is believed that any combination of these materials may be employed.

The coating of the coated structural article component is prepared by using a binder material such as a high performance heat-reactive acrylic latex polymer to bond the filler materials together and to bond the filler to the substrate. Such a binder material is Hycar 2679 acrylic latex polymer supplied by B.F. Goodrich Company of Cleveland, Ohio. It is believed, however, that any linear polymer, linear copolymer or branched polymer may be useful in preparing the coating. Possible binder materials include butyl rubber latex, SBR latex, neoprene latex, polyvinyl alcohol emulsion, SBS latex, water based polyurethane emulsions and elastomers, vinyl chloride copolymers, nitrile rubbers and polyvinyl acetate copolymers.

In a preferred embodiment, the coating of the coated structural article component may comprise nearly 85% by weight of the structural article. In that coating, approximately from 84% to 96% by weight may be filler and the remainder may be the acrylic latex binder. The filler may be approximately 50% fly ash and 50% calcium carbonate. The substrate may comprise about 15% by weight of the structural article. Glass fibers may comprise approximately 12% by weight of the article and a binder material may comprise about 3% by

20

weight of the article. The binder which bonds together the glass fibers may be from 99% to 75% (preferably 98% to 94%) by weight urea formaldehyde and from 1% to 25% (preferably 2% to 6%) by weight standard acrylic latex.

5 The substrate of the coated structural article component may be coated by air spraying, dip coating, knife coating, roll coating or film application such as lamination/heat pressing. The coating may be bonded to the substrate by chemical bonding, mechanical bonding and/or thermal bonding. Mechanical bonding may be achieved by force feeding the coating onto the substrate with a knife.

The coated structural article component made in accordance with this invention may be of any shape but preferably, such articles are planar in shape. The substrate is coated on one side or both sides depending on the intended application.

15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197

(aluminum trihydrate) available from e.g. Akzo Chemicals and antimony oxide available from e.g. Laurel Industries and/or a coloring dye such as T-1133A and iron oxide red pigments, and other products which can impart specific surface functions. The Micro-Chek products are available from the FerroCorporation of Walton Hills, Ohio. Byk-375 may be obtained from Wacker Silicone Corporation of Adrian, Mich. and T-1133A is sold by Abco Enterprises Inc. of Allegan, Mich.

The additional coatings of, e.g. water repellent material, antifungal material, antibacterial material, etc., may be applied to one or both sides of structural articles otherwise having filler/binder coatings on one or both sides of a substrate. For example, structural articles comprising substrates coated on one or both sides with filler/binder coatings could be coated on one side with a water repellent composition and on the other side with an antibacterial agent.

The substrate may be a nonwoven fiberglass mat which is desirable because it is light in weight. Fiberglass mats are also preferred as substrates because of their fire resistant nature, their resistance to moisture damage, their excellent dimensional stability, their resistance to curl with temperature changes, their resistance to rot and decay, their ability to accept organic coatings and their excellent physical properties.

Nonlimiting examples of heat reflective components include, elastomeric coatings, aluminum fiber roof coatings, ceramic coatings, acrylic and polyurethane coating systems, insulating paints such as those disclosed in U.S. Patent 4,623,390 of Delmonico, metal pigment paints, metal pigment pastes such as those disclosed in U.S. Patent No. 5,993,523 of Keemer et al., coloring dyes, colored coatings, and aluminum flakes.

The heat reflective coated structural article of the present invention has a solar reflectance, as defined by the ASTM Standards of from about 65 to about 100. In a preferred embodiment of the present invention, the heat reflective coated structural article has solar reflectance of from about 70 to about 86. In another embodiment, the heat reflective coated structural article has a visible reflectance of from about 65 to about 100. In another preferred embodiment, the heat reflective coated structural article has a visible reflectance of from about 70 to about 86.

In the present invention, solar reflectance is defined as the fraction of reflected solar energy. One method of determining the solar reflectance involves the use of spectrophotometric measurements with an integrating sphere to determine the reflectance at each different wavelength. The average reflectance is determined by an averaging process using a standard solar spectrum. The spectral range for solar energy is 300 to 2500 nanometers. This method is documented by ASTM (American Society for Testing and Materials) as standards E903 and E892. In the present invention, the visible reflectance is defined as the reflected fraction of the visual part of the solar spectrum, wavelengths 400 to 700 nanometers. The visible part of the solar spectrum does not include the ultra-violet or infrared portion of the solar spectrum.

Preferably, the heat reflective component meets the EPA's requirements and bears the Energy Star® label. EPA compliant heat reflective components include, but are not limited to, Syntec™ and Versico™ (Carlisle Syntec, Inc., Carlisle, PA); CXP Ceko™, CLP Ceko™, MAP Ceko™ and MVR Ceko™ (Ceco Building Systems, Columbus, MI); Hypalon Hy-Crown™, Rapid Roof HV™ and Benchmark™ (Conklin Co., Inc., Shakopee, MN); DSSx1.5

Galvalume™ and DSSx2 Galvalume™ (Delcoa Industries, Inc., Pompano Beach, FL); Dura-
 Loc™ (Dura-Loc Roofing Systems, Ontario, Canada); Ceramicoat EERS International™ and
 Total Shield Polyurea EERS International™ (EERS International, Inc.); Eraguard 1000™,
 Eraguard 500™, Erakote™, Erathane 300™ and Permaweld 48ml™ (Elasotmeric Roofing
 5 Systems, Loretto, MN); Flex FB Elvaloy™, Flex MF/R Elvaloy™ and Flex MF/R PVC White
 Membrane (Flex Roofing Systems, Morgantown, PA); 502 RCW Elasto-Kote, 505 Elasto-Brite
 M, 501 Elasto-Brite, 98AF and 298 Alumin-R (Karnak Corporation, Clark, New Jersey); Acrylic
 White (Metacrylics, San Jose, California); AcryShield™ A400, AcryShield™ A500,
 AcryShield™ A550, AcryShield™ A600 (National Coatings Corporation, Camarillo,
 10 California); Stevens EP, Stevens Hypalon (CSM) (Stevens Roofing Systems, Holyoke,
 Massachusetts); Weather Barrier 1650 White, and Weather Barrier 1655 White (Weather Barrier,
 Inc., Manilla, Philippines).

The heat reflective coating may also be selected from the following nonlimiting
 examples, Lo/Mit™ (SOLEC™, Ewing, New Jersey), acrylic and polyurethane Mule-Hide
 roof coating systems (Better Roofing Mid Atlantic, Inc., Jacksonville, North Carolina),
 Ceramic-Cover (Thermal Protective Systems, L.L.C., Fort Worth, Texas), and aluminum fibered
 roof coating #726 (Malarkey Roofing Co., Portland, Oregon).

The applicants' invention allows commercial roofing manufacturers to incorporate
 the heat reflective coated structural article of the present invention into their products to achieve
 20 a cost-effective, energy-efficient heat reflective product. In addition, the incorporation of the
 heat reflective coated structural article of the present invention into commercial roofing products
 eliminates the need for post-installation application of a heat reflective coating. The applicant's

invention also requires approximately 25% to 50% less reflective component than is necessary to coat conventional commercial roof products. This is because the surface of the coated structural article component is smoother than conventional commercial roofing products, which are coarse and absorb more of the heat reflective component. Furthermore, other elements of commercial roof products, such as separate glass mats, granules, gravel, asphalt, asphalt emulsions and other finishes are not required, thus making the commercial roofing material which incorporates the heat reflective coated structural article of the present invention lighter, more cost-effective, easier to manufacture and easier to install. Moreover, the applicants' heat reflective coated structural article includes a coated mat which is comprised mainly of nonflammable filler and the mat which is coated by that filled coating is also nonflammable.

The heat reflective component of the present invention is applied to one surface of the coated structural article component and may be applied to the coated structural article component by any means known in the art. If the substrate of the coated structural article component has been coated on both sides, then the heat reflective component may be applied to either side. If only one side of the substrate has been coated, then the heat reflective component is preferably applied to the coated side of the coated structural article component. For example, the heat reflective component may be laminated to the coated structural article component (*e.g.* applied as a film bonded to the coated structural article) or applied with a brush or by a spraying means or a coating means. Where the manufacturer of the heat reflective component has indicated a preferred means of application, such means may be used to apply the heat reflective component to the structural article. The surface of the heat reflective coated structural article of the present invention is the top layer of a commercial roofing material.

The heat reflective coated structural article of the present invention may be used with a variety of commercial roofing materials including, but not limited to, conventional cap sheet, APP modified bitumen sheet, SBS modified bitumen sheet and built up roofing systems. The heat reflective coated structural article of the present invention may be incorporated into commercial roofing systems, for example, by roll coating a layer of asphalt or modified asphalt to the back of the article; laminating the article to an existing asphalt coated reinforcement as the top layer during manufacturing; post-laminating the article to the top asphalt or modified asphalt layer of an existing roofing membrane using hot asphalt, cold adhesive or heat welding; and installing the article with either hot asphalt or cold adhesive directly as the top layer of a built-up roof.

In one embodiment, the heat reflective coated structural article of the present invention is back coated with an SBS modified bituminous coating to produce a finished cap sheet product which can then be applied directly to a roof using either hot asphalt, heat welding or cold adhesive. Alternatively, a layer of adhesive may be applied to the back of the heat reflective coated structural article to produce a self adhering (peel and stick) product. The product forms the top most layer of the built-up roofing system thereby imparting heat reflectance via the heat reflective coated structural article of the present invention.

In another embodiment, the heat reflective coated structural article of the present invention is applied to a sheet consisting of a glass or polyester mat encased in hot asphalt such that the article is adhered to the top layer of hot asphalt with the reflective surface up. This product can then be applied via heat welding, hot asphalt or cold adhesive over a base sheet as part of a two ply modified bitumen roof.

In a further embodiment, the heat reflective coated structural article of the present invention can be used as the last step in the construction of a built-up roof such that the article is applied to the top layer of hot asphalt in a multi-ply system with the reflective surface of the article facing up on the formed roof surface and imparting heat resistance thereto.

It should be understood that compositions other than those described above can be used while maintaining the principles underlying the present invention. For example, other sources of inert materials as well as mixtures of binders and/or additives can be used in formulating the structural articles. Other suitable types of heat reflective components can be used in combination with the coated substrate to improve the properties of the heat reflective coated structural articles formed therefrom and the heat reflective coated structural article of the present invention may be utilized together with other suitable roofing products to impart heat reflectance properties to the resultant roof.

EXAMPLES:

Example 1.

Non-water repellant Versashield™ coated structural articles (Versashield™ coated on both sides, available from Elk Corporation in Ennis, Texas) were coated on one side with one of the following heat reflective materials: 1) ARM-91-1, 2) APC-40-1 (both available from Rohm & Haas Co.), and 3) Sherwin Williams White Paint 20 Year. The Solar Reflectivity for each sample was measured by Rohm & Haas Co.'s Coating Technical Service, Springhouse, PA, using a Solar Spectrum Reflectometer, Model SSR-ER, Version 5.0. A single tungsten filament source was used that provided diffuse illumination at the sample port. Energy reflected from the sample was measured at an angle of 20 degrees from normal, with four filtered detectors. The

detectors were designated UV, Blue, Red and IR indicating the primary wavelength range each covers. The relative response of each detector in combination with the light source was designed to approximate the solar spectrum in its wavelength range. By summing the four outputs in the appropriate proportions, a solar measurement spectrum was obtained. The percentage of Solar Reflectivity is reported in TABLE II.

| TABLE II | | |
|---|----------------------|---|
| Sample ID | Reflectivity (%) | Reflectivity (%) for Those Sample Average |
| ARM-91-1 | 85.2 85.0 84.2 | 84.8 |
| APC-40-1 | 84.5 84.1 84.2 | 84.3 |
| White Sherwin Williams Paint 20 Year | 75.0 74.5 74.5 | 74.7 |
| Control-VersaShield™ | 41.3 41.5 41.5 | 41.4 |
| Lab Coated Sheet with APC-40-1 | 82.9 83.8 82.5 | 83.1 |
| Lab Coated Sheet with ARM-91-1 | 83 84.5 83.4 | 84.0 |

The present invention is not to be limited in scope by the specific embodiments described herein. Indeed, various modifications of the invention in addition to those described herein will

become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within the scope of the appended claims. Various references are cited herein, the disclosure of which are incorporated by reference in their entireties.

00444-1662450